change in the vehicle state via the operating means to the driver as tactile information; adjustment permission means for permitting an operation amount adjustment of the tactile device to start; adjustment amount input means for inputting an adjustment amount to thereby increase or decrease the operation amount of the tactile device; and simulation means for, on the basis of information pertaining to the parked vehicle detected by the parked vehicle sensor, information pertaining to the permission provided by the adjustment permission means, and information pertaining to the increase/decrease achieved by the adjustment amount input means, outputting information to activate the tactile device in the same manner as it does during traveling of the vehicle, while the vehicle is in a parked state.

**[0021]** With this arrangement, even when the vehicle is parked, the driver is allowed to confirm and adjust various conditions, such as amplitude and frequency, of the tactile pattern of the tactile device in the same manner as it achieves during traveling.

**[0022]** Preferably, the operation means comprises a steering wheel of the vehicle, which has a grip portion for being gripped by the driver. The tactile device is assembled in the grip portion of the steering wheel. The steering wheel further has a guard protrusion disposed in the grip portion and engageable with a hand of the driver to prevent the tactile device from being subjected to undue stress during steering operation.

**[0023]** The guard protrusion thus provided limits a tendency of the driver's hand to displace in a radial outward direction during steering, which will apply more force to the tactile device assembled in the grip portion. The tactile device is therefore durable and has a long service life.

**[0024]** Preferably, the operation means comprises an accelerator pedal of the vehicle, and the tactile device comprises a vibration generating mechanism assembled with the accelerator pedal. The vibration generating mechanism directly vibrates the accelerate pedal and is able to transmit vibration of the accelerate pedal directly to the driver's foot. This arrangement allows for the use of the existing accelerating pedal without reconstruction, which will lead to a reduction of the vehicle weight and cost cutting.

## BRIEF DESCRIPTION OF THE DRAWINGS

**[0025]** Certain preferred structural embodiments of the present invention will be described in detail herein below, by way of example only, with the reference to the accompanying drawings, in which:

**[0026]** FIG. **1** is a perspective view showing the general configuration of a vehicle state information transmission apparatus according to one preferred embodiment of the present invention;

**[0027]** FIG. **2** is a block diagram showing the general configuration of the vehicle state information transmission apparatus used as a vehicle warning apparatus;

**[0028]** FIG. **3** is a front elevational view of a warning means incorporated in various meter units mounted on an instrument panel of the vehicle;

**[0029]** FIG. **4**A is a cross-sectional view taken along line **4-4** of FIG. **1**, showing a tactile device incorporated in a steering wheel;

**[0030]** FIG. **4**B is a fragmentary plan view showing a portion of the steering wheel in which the tactile device is incorporated;

**[0031]** FIG. **5** is a cross-sectional view taken along line **5-5** of FIG. **4**A;

**[0032]** FIG. **6** is a plan view with parts cut away for clarity of the steering wheel portion in which the tactile device comprised of a rectangular array of linear reciprocation actuators is incorporated.

**[0033]** FIG. **7** is a cross-sectional view illustrative of the operation of the tactile device;

**[0034]** FIG. **8** is a flowchart showing a series of operations to be achieved by an electronic control device (ECU) of the vehicle warning apparatus to operate the tactile device in conjunction with the warning means;

**[0035]** FIGS. **9**A and **8**B are diagrammatical views illustrative of the operation of a parking brake reminder light (warning indicator) which is performed in conjunction with the operation of the tactile device;

**[0036]** FIGS. **10**A to **10**C are diagrammatical views illustrative of the operation of the tactile device when used in combination with the warning indicators for transmitting information about parking brake reminder or warning to the driver;

**[0037]** FIGS. **11**A to **11**G are diagrammatical views illustrative of the operation of the tactile device when used for transmitting information about incoming message to the driver;

**[0038]** FIGS. **12**A to **12**D are diagrammatical views illustrative of the operation of the tactile device when used for transmitting information about a lane departure warning;

**[0039]** FIG. **13** is a flowchart showing a series of operations to be achieved by the ECU to as to perform a tactile vehicle state information transmission operation using the tactile device;

**[0040]** FIG. **14**A is a table map showing a correlation between lateral acceleration and frequency for use in a tactile pattern determining operation shown in FIG. **13**;

**[0041]** FIG. **14**B is a table map showing a correlation between the vehicle speed and the frequency for use in the tactile pattern determining operation shown in FIG. **13**:

**[0042]** FIGS. **15**A to **15**E are diagrammatical views illustrative of the operation performed by the tactile device to transmit tactile vehicle state information via the steering wheel to the driver as the diver turns the steering wheel from the neutral position in a counterclockwise direction through an angle not more than 90 degrees, and preferably 75 degrees;

**[0043]** FIGS. **16**A to **16**E are diagrammatical views showing the operation performed by the tactile device to transmit tactile information vie the steering wheel to the driver when the driver further turns the steering wheel counterclockwise to a position approximately 90-degrees ahead of the neutral position;

**[0044]** FIGS. **17**A to **17**E are diagrammatical views showing the operation performed by the tactile device to transmit tactile information vie the steering wheel to the driver when the driver further turns the steering wheel counter-clockwise to a position approximately 180-degrees ahead of the neutral position;

**[0045]** FIG. **18**A is a vertical cross-sectional view of a tactile device according another embodiment of the invention, including a first tactile unit assembled with an accelerator pedal and a second tactile unit assembled with a vehicle floor at a position appropriate for engagement with the heel of a driver's foot;

**[0046]** FIG. **18**B is a perspective view with parts cut away for clarity of the tactile device shown in FIG. **18**A;